



## REMR TECHNICAL NOTE CS-MR-3.7

### CRACK REPAIR METHOD: GROUTING (PORTLAND-CEMENT AND CHEMICAL)

PURPOSE: To provide guidance on use of grouting to repair cracks in concrete. (NOTE: Before selecting any method for repair of cracks, REMR Technical Note CS-MR-3.1, "Selection of a Crack Repair Method," should be reviewed.)

DESCRIPTION: This method consists of cleaning the concrete along the crack, installing injection ports (grout nipples) at intervals astride the crack (to provide a pressure-tight contact with the injection apparatus), sealing the crack between the injection ports, flushing the crack to clean it and test the seal, and then grouting the crack.

EQUIPMENT, TOOLS, AND PERSONNEL REQUIREMENTS: A concrete drill, a grout injection system, a means of cleaning holes and cracks (usually a water flush), and normal hand tools are required. A two- or three-man crew is normally required. Grouting requires personnel with a high degree of skill and expertise.

APPLICATIONS AND LIMITATIONS: This method can be used to repair cracks that are dormant, particularly in gravity dams and thick concrete walls. Portland-cement grout can be used to repair wide cracks, and chemical grout can be used to seal cracks in concrete as narrow as 0.002 in. Grouting (both portland-cement and chemical) can be used successfully in a moist environment. The disadvantage is that grouting requires a high degree of skill and expertise for satisfactory use. Chemical grouting has the added disadvantage of high cost, shelf life considerations, lack of strength, more stringent safety precautions, and volume shrinkage if allowed to dry out.

#### STEP-BY-STEP PROCEDURE:

- a. Clean the concrete along the crack.
- b. Seal the surface. Surface cracks should be sealed to keep the grout from leaking out before it has set. Where the crack face cannot be reached, but where there is backfill, or where a slab-ongrade is being repaired, the backfill material or subbase material is often an adequate seal. Numerous materials and techniques may be used to seal surface cracks depending on crack size and the grouting pressure to be used. For low grouting pressures, a good strong water-resistant tape may be sufficient, whereas for high pressures, an epoxy seal using the routing and sealing method (REMR Technical Note CS-MR-3.2) may be appropriate. Normally a cement paint or grout seal is used.
- c. Install the entry ports. Three methods are in general use:

1. Drilled holes--fittings inserted. Historically, this method was the first to be used, and is often used in conjunction with V-grooving of the cracks. The method entails drilling a hole into the crack, approximately 3/4 in. in diameter and 1/2 to 1 in. below the apex of the V-grooved section, into which a fitting such as a pipe nipple or tire valve stem is bonded. A vacuum chuck and bit are useful in preventing the cracks from being plugged with drilling dust.
2. Bonded flush fitting. When the cracks are not V-grooved, a method frequently used to provide an entry port is to bond a fitting flush with the concrete face over the crack. This flush fitting has a hat-like cross section with an opening at the top for the grout to enter.
3. Interruption in seal. Another means of providing entry is to omit the seal from a portion of the crack. This method can be used when special gasket devices are available that cover the unsealed portion of the crack and allow injection of the grout directly into the crack without leaking.
- d. Flush the crack. When the crack has been sealed, it is flushed with water to clean it and test the seal for leaks.
- e. Mix the grout. Portland-cement grout mixtures may vary in volumetric proportion from one part cement and five parts water to one part cement and one part water. The water-cement ratio should be kept as low as practical to maximize strength and minimize shrinkage. Chemical grouts consist of solutions of two or more chemicals that react to form a gel or a solid precipitate. A variety of mechanical mixers are available for mixing grout as described in Engineer Manual 1110-2--3506.
- f. Inject the grout:
  1. For small volumes, a manual injection gun may be used; for larger volumes, a pump should be used. The pressure used for injection must be carefully selected based on grout properties, crack characteristics, and structural integrity of the medium to be grouted.
  2. If the crack is vertical, the injection process should begin with pumping grout into the entry port at the lowest elevation until the grout level reaches the entry port above. The lower injection port is then capped, and the process is repeated at successively higher ports until the crack has been completely filled and all ports have been capped.
  3. For horizontal cracks, injection should proceed from one end of the crack to the other in the same manner. The crack is full if the pressure can be maintained. If the pressure cannot be maintained, the grout is still flowing into unfilled portions or leaking out of the crack.

ENVIRONMENTAL CONSIDERATIONS: Reasonable caution should guide the preparation, repair, and cleanup phases of any crack repair activities involving potentially hazardous and toxic chemical substances. Manufacturer's recommendations to protect occupational health and environmental quality should be carefully followed. In instances where the effects of a chemical substance on occupational health or environmental quality are unknown, chemical substances should be treated as potentially hazardous and toxic materials.

- REFERENCES:
- a. Maintenance and repair of concrete and concrete structures. US Army Corps of Engineers, Washington, DC, 1979. Engineer Manual 1110-2-2002.
  - b. Causes, evaluation, and repair of cracks. ACI Committee 224. In: Journal of the American Concrete Institute, Vol 81, No. 3, American Concrete Institute, Detroit, MI, 1984. ACI 224.1R-84.
  - c. Chemical grouting. US Army Corps of Engineers, Washington, DC, May 1973. Engineer Manual 1110-2-3504.
  - d. Grouting technology. US Army Corps of Engineers, Washington, DC, Jan 1984. Engineer Manual 1110-2-3506.